

RESEARCH ARTICLE OPEN ACCESS

Empowering Circular Startups: Unveiling the Blueprint for Circular Business Models

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Received: 30 January 2025 | **Revised:** 19 January 2026 | **Accepted:** 28 January 2026

Keywords: circular business model | classification | entrepreneurship | startup | taxonomy

ABSTRACT

Circular startups are increasingly recognized as key drivers in the transition toward a circular economy. Yet the business models (BMs) through which these startups operationalize circularity remain poorly understood, limiting the ability of entrepreneurial ecosystem actors to offer effective support. This study addresses this gap by developing a taxonomy that captures how startups embed circularity into their BMs, across value proposition, value creation, and value network. Drawing on a dataset of 125 startups and grounded in BM theory, it combines conceptual synthesis, empirical coding, and expert evaluation. The resulting taxonomy comprises 10 dimensions and 48 characteristics. Our findings show how circular startups integrate environmental and social value creation, adopt ownership and sales models aligned with circular goals, and rely on cross-sector collaboration to compensate for limited infrastructures. The taxonomy offers entrepreneurial ecosystem actors a practical tool to assess startup needs, identify circularity gaps, and design targeted support strategies.

1 | Introduction

The circular economy (CE) has emerged as a guiding paradigm for sustainable development, aiming to decouple economic growth from resource depletion by closing material and product loops and minimizing waste (Geissdoerfer et al. 2018; Kirchherr et al. 2023). This transition requires a fundamental rethinking of how value is created, delivered, and captured, urging businesses to redesign their core logics toward circularity. Although incumbent firms hold the potential for large-scale impact, their legacy structures and organizational inertia often hinder radical innovation (Lüdeke-Freund et al. 2019). In contrast, startups can design circular business models (CBMs) from the outset (Schaltegger et al. 2016), thus serving as key agents of innovation in the transition toward a CE.

Circular startups play a pivotal role in this transformation by pioneering novel ways of creating, delivering, and capturing

value under circular logic. However, their efforts are hampered by several challenges, such as limited resources, uncertain markets, complex stakeholder environments, and long development cycles, which make the development and scaling of CBMs particularly demanding (Kanda et al. 2024). Entrepreneurial ecosystems (EEs) have been shown to mitigate these challenges by providing support infrastructure, access to networks, and complementary resources (Bustamante 2019; Woolley and MacGregor 2022). Yet the effectiveness of such support is contingent upon a nuanced understanding of how circular startups operate, that is, how they create, deliver, and capture value under circular logic.

Although the literature on CBMs has expanded in recent years, it tends to focus on incumbents that do not reflect the operational realities of startups (Urbinati et al. 2017) or offer typologies that fail to account for the heterogeneity and configurational complexity observed in circular startups (Henry et al. 2020). As a result, EE actors, such as incubators,

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investors, and policymakers, often lack the tools to assess a startup's circularity logic or identify its support needs. This misalignment can lead to inefficient support allocation, missed opportunities for innovation, and, ultimately, slower progress toward a CE.

Addressing this gap requires a structured and empirically grounded understanding of how circular startups operationalize CE principles within their business models (BMs). Understanding these configurations is essential for designing targeted support measures, evaluating startup potential, and strategically managing EE portfolios.

To this end, this study develops a taxonomy that captures the key dimensions and characteristics of circular startups' BMs. Grounded in BM theory and developed through a multiphase, multimethod approach, the taxonomy offers a tool to classify and compare CBMs systematically and provides practical guidance for EE actors. Our guiding research question is as follows:

What dimensions and characteristics define CBMs of startups?

We contribute to CBM theory by showing how startups embed circularity through distinct, multidimensional BM configurations. This advances the conceptualization of CBMs in the context of startups, where existing frameworks often fall short.

In addition to its theoretical relevance, the taxonomy is designed to support practical application: It enables EE actors to identify the specific needs and challenges of circular startups, connect them with relevant resources and expertise, and assess where circularity can be further strengthened. Moreover, by mapping BM diversity across startups, the taxonomy supports a more strategic management of EE portfolios and provides a common language that facilitates coordination and alignment among stakeholders. In doing so, it helps translate the abstract goals of the CE into concrete, organizational practices, thereby supporting one of its most dynamic drivers: circular startups.

The structure of this paper is as follows: Section 2 introduces the concept of CE and offers a literature review on CBMs, identifying the limitations of current taxonomies and frameworks. Section 3 outlines the methodology employed to develop the new taxonomy, and Section 4 presents and deliberates upon the findings. A real-world application example of the taxonomy is given in Section 5. Section 6 introduces a discussion, a comparison to prior work, implications for theoretical development and practical application, and advocates for continued research efforts in the field. Finally, Section 7 offers concluding remarks.

2 | Related Work

The CE has become a focal point in academic, political, and business contexts as a way to mitigate waste and pollution. At its core, the CE seeks to narrow, slow, and close resource loops (Geissdoerfer et al. 2017; Stahel 2012). These strategies are operationalized through a set of R-principles: reduce, reuse, repair, and recycle, which form the conceptual and practical core of CE implementations (Kirchherr et al. 2023; Potting et al. 2017). Although incumbent firms possess the potential to implement these circular strategies at scale, empirical research highlights the challenges they face in transitioning legacy systems. Organizational inertia and path dependencies often lead to incremental adaptations rather than fundamental redesign (Lüdeke-Freund et al. 2019). In contrast, startups can embed CE principles from inception, designing CBMs from the ground up, integrating circularity as a constitutive element rather than a retrofit (Han et al. 2023; Henry et al. 2020).

Circular startups differ fundamentally from both conventional startups and established firms. Defined as "new, independent and active companies pursuing a CBM" (Henry et al. 2020, 2), they combine economic viability with intentional environmental and social value creation. This distinguishes them from conventional startups, which typically prioritize economic returns while treating sustainability as a secondary concern (Geissdoerfer et al. 2020). The difference to incumbent firms is depicted in Table 1.

TABLE 1 | A comparison of CBM: Startups versus incumbent firms.

Dimension	Circular startup	Incumbent firms
Strategic orientation	Circularity is core to the business model from inception	Circularity is integrated into existing business models as an adaptation
Path dependencies	No legacy systems or sunk costs give them greater flexibility	Strong legacy systems and path dependencies limiting their adaptability
Innovation type	Often radical, experimentation-driven innovation	Often incremental innovation, constrained by existing processes
Organizational resources	Operate with limited resources and lean structures	Access to significant resources, formalized structures
Value orientation	Holistic value creation: environmental, social, and economic dimensions integrated	Economic value primary, environmental and social values often treated as externalities
Risk orientation	High uncertainty and rapid iteration cycles	Risk managed through stability and gradual change
Support needs	Require tailored ecosystem support (e.g., mentorship, legitimacy, and early-stage capital)	Require support for transformation (e.g., retraining, infrastructure, and reorganization)

Operating under resource scarcity, institutional uncertainty, and limited market legitimacy, startups often pursue more radical and experimental approaches to BM design. They embody what has been termed “resource mindfulness,” actively embedding use–re-use–recycle strategies in their offerings and operations (Stahel 2012). However, these advantages are accompanied by significant barriers. Circular startups must develop their CBM from scratch while simultaneously navigating sectoral constraints, underdeveloped regulatory environments, and financing gaps (Kanda et al. 2024).

EEs have been shown to play a decisive role in enabling startups to overcome these barriers, influencing their survival and success (Bustamante 2019). Defined as “a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory” (Stam and Spigel 2016, 1), EEs comprise support organizations, institutions, infrastructure, and networks that facilitate startup development. Their local and regional nature is particularly relevant for circular startups, which often operate at the intersection of material flows, regulations, and industrial networks (Neumeyer and Santos 2018).

Recent studies highlight that EEs are instrumental in accelerating the transition toward a CE by fostering startups that embed circularity in their business logic (Woolley and MacGregor 2022). However, to do so effectively, ecosystem actors must understand the distinct structural and strategic features of startups’ CBMs. This necessitates analytical frameworks that go beyond generic startup support and allow for differentiated, need-based interventions (Kanda et al. 2024).

To investigate how circularity is embedded in startup CBMs, this study adopts the BM perspective as its guiding theoretical lens. BM theory is concerned with how organizations structure activities to create, deliver, and capture value (Osterwalder et al. 2005; Teece 2010). It is particularly well-suited for understanding novel organizational forms, such as circular startups, that depart from traditional models in both logic and configuration.

Scholars typically distinguish four core elements in BM frameworks: value proposition, value creation, value capture, and value network (Al-Debei and Avison 2010; Chesbrough 2010; Johnson et al. 2008; Morris et al. 2005). The value proposition defines what is offered and to whom; value creation encompasses the activities, resources, processes, and capabilities used to deliver the proposition; value capture refers to the financial and nonfinancial returns generated; and the value network includes external actors and partnerships enabling these processes (Chesbrough 2010; Johnson et al. 2008; Lacy et al. 2020).

The business model canvas (BMC) (Osterwalder et al. 2005) provides a widely adopted framework for visualizing these components along nine building blocks. However, the BM lens also enables deeper analytical work, such as identifying innovation patterns, mapping systemic coherence, and theorizing new forms of value (Teece 2010; Zott et al. 2011). In the context of circular startups, it helps reveal how CE principles are embedded across structural dimensions, not merely as goals, but as operational design logic.

To render the complexity of CBMs analytically tractable, classification systems such as taxonomies and typologies are essential. These tools aid in organizing knowledge domains, identifying configuration patterns, and offering systematic vocabularies (Nickerson et al. 2013). Although the terms are often used interchangeably, typologies are usually deductively derived from theoretical principles, whereas taxonomies are often inductively developed through empirical observation (Schoormann et al. 2023). A process for creating a taxonomy that harmonizes these two approaches was developed by Nickerson et al. (2013).

In the CE domain, multiple taxonomies and typologies have been proposed. For example, Lewandowski (2016) expanded the BMC by incorporating CE-specific elements, such as take-back systems. Lüdeke-Freund et al. (2019) identified six major CBM patterns, whereas others have explored product lifecycle models, governance structures, or sectoral distinctions (Blomsma et al. 2019; Bressanelli et al. 2018; Galvão et al. 2020; Moreno et al. 2016). Despite growing interest in this phenomenon, these classifications primarily reflect the strategies of established and mature firms, leaving the structural and strategic particularities of startup CBMs underexplored (Blomsma et al. 2019; Urbinati et al. 2017).

Henry et al. (2020) provided a notable exception by proposing a typology of circular startups based on five archetypes: design, waste, platform, service, and nature. However, their typology was built deductively on an adapted version of CE principles combined with Urbinati et al.’s (2017) taxonomy and lacks the configurational granularity necessary for analytical application or practical support design. Moreover, several startups could not be clearly assigned to any of the proposed archetypes, highlighting the limitations of a typological approach in capturing the multidimensional nature of circular startup BMs. To date, to the best of the authors’ knowledge, no taxonomy exists that both defines and systematically captures the structural and strategic logics of how circular startups integrate CE strategies and R-principles into their value proposition, value creation, and value network.

This study addresses this research gap by developing a taxonomy grounded in BM theory and empirically derived from 125 circular startups. In doing so, it provides EE actors and researchers with a tool to analyze, compare, and support circular startups more effectively. The taxonomy identifies key CBM dimensions, highlights interdependencies, and enables need-based support, the enhancement of circularity, strategic coordination, and a shared vocabulary within EEs.

3 | Methodology

3.1 | Taxonomy Development Approach

To systematically identify and classify the dimensions through which circular startups operationalize circularity, this study follows a structured taxonomy development approach. Building on the iterative framework proposed by Kundisch et al. (2022), the process comprises three main phases: (1) defining the taxonomy’s objectives, (2) designing and developing the taxonomy through successive iterations, and (3) evaluating its usefulness

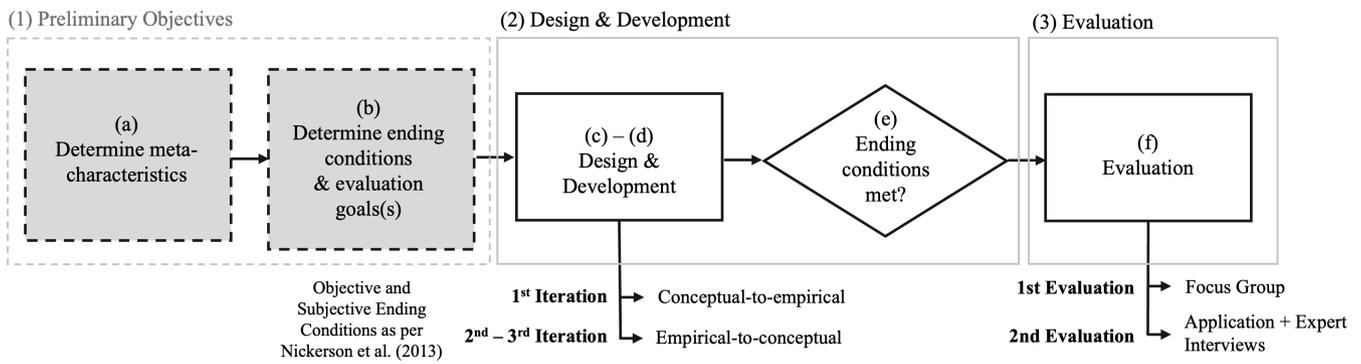


FIGURE 1 | Taxonomy development process adopted by Kundisch et al. (2022).

and applicability for ecosystem actors, illustrated by our process model (see Figure 1). This methodology integrates conceptual rigor with empirical grounding, allowing for a systematic abstraction of BM dimensions from real-world cases while remaining anchored in extant theoretical frameworks.

The first phase focused on specifying the preliminary objectives. Step (a) involved defining the meta-characteristic of the taxonomy, which guided all subsequent development choices: “to facilitate a comprehensive understanding of the key distinguishing dimensions and characteristics of CBMs.” In Step (b), we established a set of ending conditions to determine when the taxonomy would be considered sufficiently developed following Nickerson et al.’s (2013) approach. Objective criteria included saturation (no new dimensions emerging) and completeness (at least one characteristic per dimension); for further details, see Appendix A. Subjective conditions required the taxonomy to be perceived as comprehensive, concise, explanatory, and robust in the judgment of the researchers (Nickerson et al. 2013). Finally, we set a clear evaluation goal: to enable EE actors working with circular startups to apply the taxonomy effectively. Users should be able to identify a circular startup and understand its CBM in detail. These criteria ensured a methodologically sound and practically relevant classification system.

Phase 2 comprised the iterative construction of the taxonomy across Steps (c)–(e). In the first iteration (Step c), we adopted a conceptual-to-empirical approach, drawing from the literature on CE and BMs to generate initial taxonomy dimensions. In the second and third iterations (Step d), we applied an empirical-to-conceptual approach, analyzing 125 real-world startup cases to refine dimensions and characteristics inductively. In each cycle, we reassessed the predefined ending conditions (Step e) to determine whether additional iterations were required. The process concluded once the taxonomy met both objective and subjective quality standards.

In the final phase (Step f), we assessed the taxonomy’s practical relevance and conceptual soundness through a two-step evaluation. First, we conducted a focus group workshop to validate usability, applicability, and extensibility. Second, we performed individual taxonomy applications, including expert interviews, to gather detailed feedback and identify potential areas for refinement. These insights informed final design adjustments, ensuring that the taxonomy would be both academically robust and practically applicable for EE stakeholders.

Throughout the process, the taxonomy was anchored in the BM lens, structuring all dimensions around the core elements of value proposition, value creation, and value network (Johnson et al. 2008; Osterwalder et al. 2005). This ensured theoretical consistency and analytical alignment with established BM frameworks. The combination of rigorous iteration, multisource conceptualization, and targeted evaluation resulted in a taxonomy that is both analytically robust and practically actionable for EE actors.

3.2 | Design Iterations for Taxonomy Construction

3.2.1 | First Iteration

In the first iteration of the taxonomy development process, we employed a conceptual-to-empirical approach (Nickerson et al. 2013), enabling us to build on the current body of knowledge at the intersection of CE, entrepreneurship, and startup BM research. To this end, we conducted a systematic literature review (SLR) in June 2023, following the methodological guidelines proposed by Kraus et al. (2020). The literature search was performed across two major academic databases, Scopus and Web of Science, using combinations of keywords such as “circular economy,” “business model,” “startup,” and “typology.” This yielded an initial dataset of 1169 publications. We then applied a multistage screening protocol: First, duplicates were removed, and only peer-reviewed journal articles in English were retained. Second, we screened titles, abstracts, and full texts to include only those studies that explicitly addressed both CE and startups’ BMs. After applying these criteria, the core corpus was reduced to 49 studies. Through backward and forward citation tracking, six additional relevant studies were included, resulting in a final sample of 55 publications (see Figure 2 for the selection process).

From this literature base, we systematically extracted and coded recurring concepts related to how circularity is embedded in startup CBMs, following the qualitative thematic analysis of Braun and Clarke (2006). To synthesize and structure these findings, we constructed a concept matrix (vom Brocke et al. 2009; Webster and Watson 2002) (see Appendix B) that mapped conceptual constructs across studies. This process surfaced 15 recurring dimensions, forming the structural basis for the subsequent empirical iterations, as shown in Figure 3.

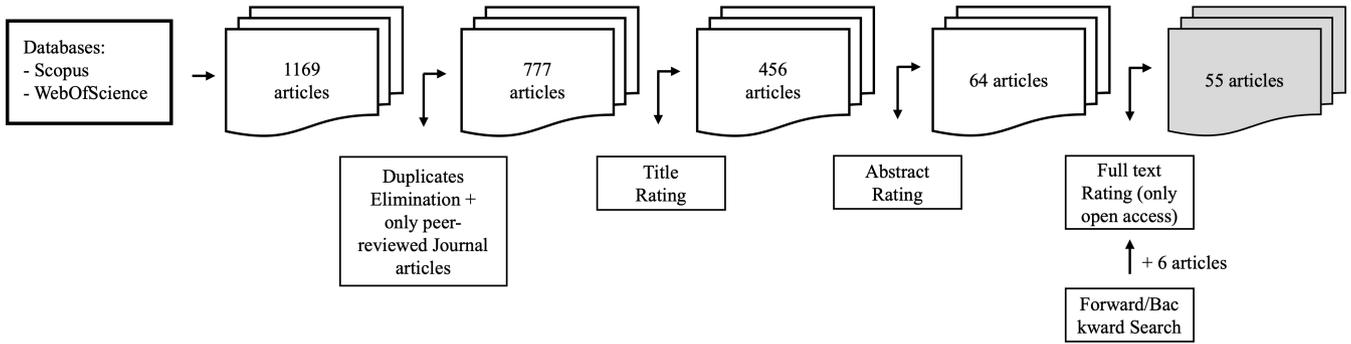


FIGURE 2 | Overview of the systematic literature review publication selection process (own illustration).

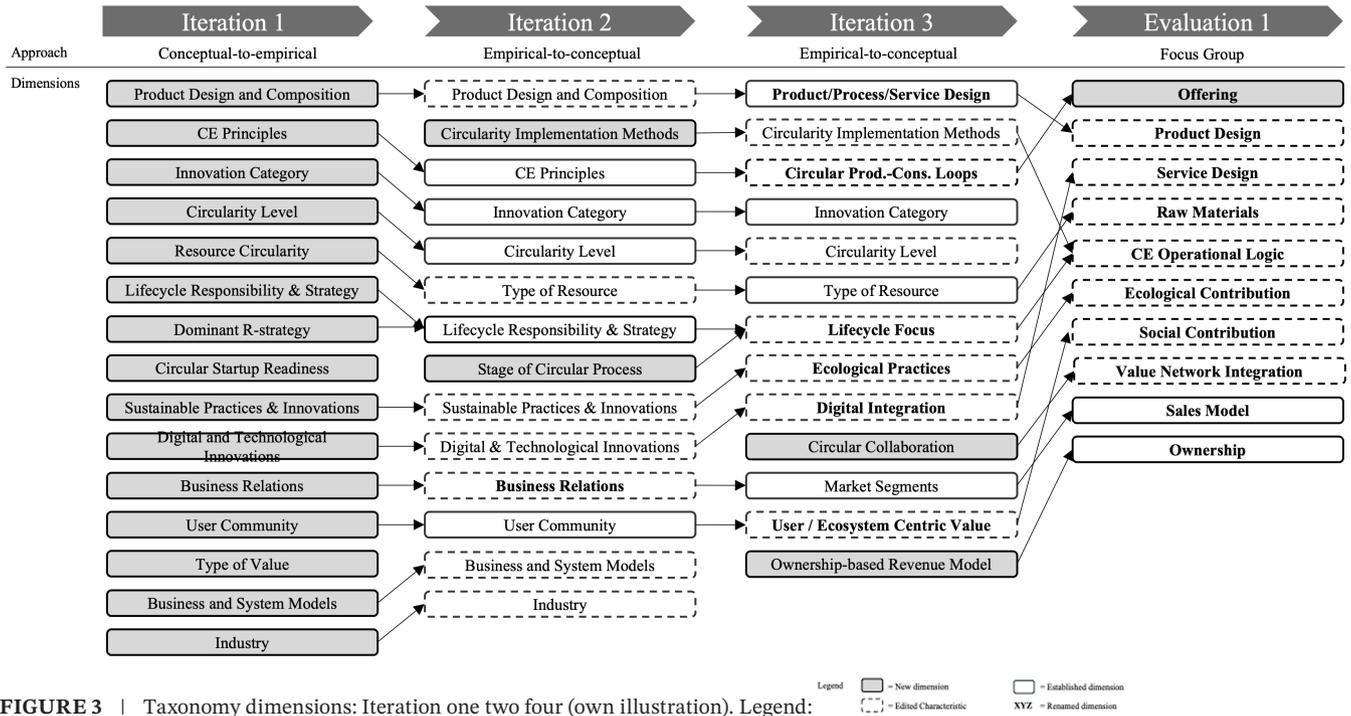


FIGURE 3 | Taxonomy dimensions: Iteration one two four (own illustration). Legend:

3.2.2 | Second Iteration

We proceeded with a second, empirical-to-conceptual iteration, inductively refining the taxonomy through real-world startup data. A dataset of 125 circular startups was compiled from five curated sources: the Ellen MacArthur Foundation's *Circular Startup Index*, Crunchbase, Dealroom, EU Startups, and the *Circular Startup Landscape* by UnternehmerTUM (see Table S1). Each source contributed 25 randomly selected startups. These databases were chosen for their global recognition in entrepreneurship research (Dalle et al. 2017; McCarthy et al. 2023) and their established focus on CE-related innovation.

To ensure conceptual consistency, inclusion criteria aligned with the EU's startup definition (European Commission 2020): All firms had fewer than 250 employees, were founded between 2018 and 2023, were active at the time of data collection (November 2023), and had annual revenues below 50 million Euros. For Crunchbase, Dealroom, and EU Startups, additional filters were applied to include only startups aligned with the definition of circular startups outlined in Section 2. The two CE-focused repositories already applied these criteria at source.

In this phase, we conducted desk research to systematically assess each startup's CBM based on publicly available information (e.g., websites, press coverage, and reports). Each case was coded against the preliminary taxonomy dimensions and characteristics. We recorded the presence or absence of characteristics and noted emerging patterns or inconsistencies. Where characteristics proved empirically irrelevant, overly broad, or duplicative, they were revised or removed. Conversely, when novel or recurring attributes appeared across cases, they were introduced as new dimensions or characteristics. This inductive analysis allowed the taxonomy to reflect empirically grounded distinctions within startup CBMs. Figure 3 depicts the changes in the taxonomies' dimensions. Upon reviewing the ending conditions, we determined that saturation had not yet been achieved. A third iteration was therefore required to further validate and refine the classification schema.

3.2.3 | Third Iteration

In the third iteration, we continued with an empirical-to-conceptual approach, aiming to sharpen the taxonomy's clarity,

distinctiveness, and conceptual robustness. Using the same dataset of 125 startups, we revisited all cases with a focus on borderline or ambiguous classifications to evaluate whether characteristics or dimensions required further refinement, for example, splitting overly broad categories, merging overlapping ones, or renaming unclear labels. The revision process was supported by intensive team discussions, ensuring interpretive consistency and definitional precision across dimensions. Where relevant, we also returned to the literature to triangulate emergent interpretations, thus maintaining our multimethod approach.

Throughout iterations two and three, we continuously documented the taxonomy's evolution using an iterative tracking model (see Figure 3), which visualized how dimensions were added, collapsed, or restructured. By the end of the third iteration, the taxonomy had stabilized at 13 dimensions and 53 characteristics, striking a balance between theoretical comprehensiveness and empirical observability.

Several dimensions initially derived from literature, such as “circular startup readiness,” “type of value,” “business and system models,” and “industry,” were removed. These were either not empirically observable based on publicly available data, lacked discriminative power across cases, or overlapped conceptually with more informative dimensions. Conversely, we identified several novel dimensions grounded in the empirical data.

First, we introduced a *circularity implementation* dimension to capture how circular practices were enacted, for example, through reuse, product return, or loop-enabling infrastructure. Second, a new *circular collaboration* dimension was added to reflect the depth and function of external partnerships. Third, we included an *ownership* dimension distinguishing whether a startup retains ownership of its offering or transfers it to the end-user. Although finer distinctions, such as rental versus usage-based models, might theoretically yield further insights, they were often not inferable from public sources. For conceptual clarity and coding reliability, we applied a binary categorization: producer ownership (retained) versus consumer ownership (transferred).

Additionally, several dimensions were refined through renaming, merging, or splitting to enhance analytical clarity and empirical fit. For example, the initially separate categories of R-strategies and lifecycle responsibility were integrated into a unified *lifecycle focus* dimension. This consolidated structure captures both the strategic intent (e.g., reduce, reuse, and recycle) and the operational focus of circularity across the product lifecycle, from material sourcing to end-of-life management. Whereas some dimensions, such as *lifecycle focus*, encompass a broad spectrum of practices, we ensured analytical consistency by grounding them in established conceptual frameworks and clearly delineating subcategories with robust coding rules. These refinements enhanced the taxonomy's conceptual coherence while maintaining empirical discriminability.

After evaluating more than 20 additional startups without encountering any new characteristics or dimensions, we determined that theoretical saturation had been reached. All objective ending conditions (Nickerson et al. 2013), including coverage of all cases, at least one characteristic per dimension,

and no emerging categories, were fulfilled. Likewise, subjective criteria such as conciseness and comprehensiveness were met. We thus concluded the design phase with a robust, empirically grounded taxonomy, ready for formal evaluation in the next step.

3.3 | Evaluation and Refinement

Following the completion of the iterative design phase, we conducted a structured, two-stage evaluation to assess the taxonomy's practical relevance, conceptual clarity, and completeness. Aligned with the evaluation goals defined in Phase 1, this process combined (1) a focus group workshop and (2) expert application trials accompanied by qualitative feedback. The evaluation was designed to validate the taxonomy against practitioner and domain-expert perspectives, as well as to identify areas for refinement. Insights from both stages informed targeted revisions, culminating in the final version of the taxonomy.

3.3.1 | Focus Group Workshop

The first stage of the evaluation consisted of a structured focus group workshop conducted in December 2023. We convened a panel of 10 academic experts with domain expertise in BM design, (sustainable) entrepreneurship, and taxonomy development. In line with established guidelines for taxonomy validation (Szopinski et al. 2019), the workshop aimed to assess the taxonomy's clarity, usefulness, and applicability in a collaborative setting.

The 2-h session began with a walkthrough of the taxonomy, during which participants were introduced to each dimension and its respective characteristics. Participants were invited to provide real-time feedback regarding comprehensibility, scope, and relevance of the taxonomy elements. To enhance the practical salience of the evaluation, we presented three real-world circular startups not included in the original dataset of 125 startups. These cases served as classification exercises to test whether the taxonomy could accommodate unfamiliar BMs and to simulate realistic application scenarios (Cledou et al. 2018).

The focus group confirmed the taxonomy's utility in dissecting the core configuration of a startup's CBM and its potential to guide ecosystem actors in identifying strengths and gaps. Experts emphasized the value of the taxonomy for both analytical and strategic purposes. At the same time, several areas for refinement emerged. First, some dimensions showed partial conceptual overlap. For example, the characteristics under the preliminary *circular production-consumption loops* dimension were found to intersect with those in *product/process/service design*, prompting the recommendation to consolidate or clarify these categories. Second, participants suggested introducing a higher level distinction between product- and service-based CBMs at the outset of the taxonomy to improve usability and logical flow, prompting the creation of the *offering* dimension.

Moreover, the dimension *innovation category* was considered difficult to apply consistently across startups and was therefore recommended for removal to enhance parsimony. Excluding

this dimension reduces analytical granularity in assessing the technological or market novelty of circular startups, thereby limiting fine-grained comparisons across innovation types. The inclusion of a separate dimension for assessing the level of circularity was also challenged. Experts argued that circularity should emerge from the configuration of characteristics rather than be predefined as a discrete classification. As such, they proposed treating “circularity level” as an outcome of the classification process rather than a fixed taxonomy dimension. Additional feedback addressed terminology: For instance, the label *technical nutrients* was flagged as ambiguous and revised for clarity. Finally, participants recommended including open characteristics (e.g., *other*) in select dimensions such as *CE implementation method* and *market segment* to accommodate outlier cases.

Based on the focus groups’ input, we revised the taxonomy to improve definitional clarity, eliminate redundancies, and enhance its applicability as depicted in Figure 3. These revisions formed the basis for the second evaluation phase.

3.3.2 | Expert Application

The second evaluation phase aimed to assess the revised taxonomy from a practical, user-oriented perspective and to identify any remaining conceptual or operational gaps. To ensure external validity and minimize bias, we recruited five independent experts with no prior involvement in the taxonomy’s development. Drawing on guidelines for taxonomy evaluation (Kundisch et al. 2022), our expert panel included two ecosystem actors from a circular support initiative, one circular startup founder, and one researcher specializing in circular entrepreneurship.

Each expert received a detailed documentation package containing the full taxonomy, definitions of all dimensions and characteristics, and three illustrative startup cases. These examples served as both an instructional guide and a basis for hands-on testing. Participants were asked to classify these cases using the taxonomy and, optionally, apply it to additional startups from their own experience. Feedback was collected via written reflections and, in three cases, supplemented by semistructured interviews lasting approximately 30 min. In line with established evaluation protocols (Szopinski et al. 2019), open-ended prompts were used to assess the taxonomy’s adequacy, applicability, completeness, and relevance.

We analyzed the qualitative data using structured content analysis (Mayring 2014), employing a deductive coding scheme based on the taxonomy’s meta-characteristics and dimensions. This analysis, conducted using QCAMap software, confirmed the robustness of many refinements introduced after the focus group stage while surfacing additional fine-grained suggestions for improvement.

Overall, practitioners affirmed the taxonomy’s practical value as an analytical framework for understanding startup CBMs. They emphasized its utility in pinpointing configuration gaps, enhancing circularity, and identifying targeted support opportunities within EEs. Nonetheless, several areas for enhancement

were noted. First, the labeling of absent characteristics using generic terms like *none* was deemed imprecise. We responded by introducing more explicit descriptors (e.g., *no product offering* and *no social contribution*) to minimize ambiguity. Second, terminology for material properties, such as *recyclable*, was revised to prevent misinterpretation. For instance, experts cautioned that materials deemed recyclable only under specialized conditions should not be uniformly categorized as such without contextual clarification.

The evaluation also prompted refinement of dimensions capturing *ecological and social contributions*. Although their inclusion was validated, experts recommended greater differentiation within these categories. For example, *indirect social contributions*, such as donations and awareness-raising initiatives, were identified as conceptually distinct and thus warrant separate classification. In contrast, the previous structuring of ecological impact along the planetary boundaries’ framework was considered too abstract for nonacademic users. We therefore simplified this dimension to improve accessibility and practical relevance.

Finally, the taxonomy’s structural logic was adjusted to enhance navigability. The sequence of dimensions was reordered to reflect a typical BM logic, beginning with the nature of the *offering* (product or service), followed by dimensions tailored to each type. This structural refinement aligns with feedback suggesting the taxonomy should offer a guided, intuitive user experience. As a result of the evaluation process, a final set of operations, including additions, deletions, renaming, and reordering of elements, was applied in accordance with the taxonomy design guidelines proposed by Kundisch et al. (2022).

Having met our predefined evaluation goal and confirmed the taxonomy’s conceptual integrity and practical utility, we concluded the development process with a validated and application-ready classification framework.

4 | Circular Startup Business Model Taxonomy

Following three iterative design phases and two evaluation cycles with expert feedback, we present the final taxonomy of CBMs for startups. The taxonomy is structured as a morphological box as illustrated in Figure 4. It comprises 10 dimensions, each with multiple characteristics, organized along the core components of the BM framework: value proposition, value creation, and value network. This reflects the functional logic through which circular startups generate and deliver value.

The sequence of dimensions is intentionally designed to support analytical applications. It begins with the fundamental nature of the startup’s offering, whether product or service, which determines the structural basis of the BM. This foundation is then examined in more detail through dimensions that capture how circularity is embedded in design choices, material sourcing, and operational logic. The taxonomy further assesses how these practices translate into tangible ecological and social contributions, thereby incorporating the broader sustainability perspective. Finally, the taxonomy analyzes

	Dimension	Characteristics									
Value Proposition	Offering	Product						Service			
	Product Design	Low Resource Input	Longevity	Modularity and Adaptability	Material Circulation	Conventional Product Design	No Product Offering				
	Service Design							Algorithm-based (incl. AI)	Collaborative Consumption Platform	Supportive Infrastructure	Conventional Service Design
Value Creation	Raw Materials	Recycled Materials	Recyclable Materials	Biodegradable Materials	Renewable Materials	Traditional Sourcing	No Product Offering				
	CE Operational Logic	Reduce	Reuse		Repair		Recycle	Enable Others		No Contribution to CE	
	Ecological Contribution	Land		Air		Water	Indirect Ecological Contribution		No Ecological Contribution		
	Social Contribution	Employment	Education		Community Engagement		Other	Indirect Social Contribution		No Social Contribution	
Value Network	Value Network Integration	Cross Industry Collaboration		Value Chain Collaboration		Knowledge-Based Collaborations		Other		No Integration	
	Sales Model	B2B		B2C		C2C		B2G		Alternative Models	
	Ownership	Producer						Consumer			

FIGURE 4 | Taxonomy for circular startup business models (own illustration). Abbreviations: B2B, business-to-business; B2G, business-to-government; B2C, business-to-consumer; C2C, consumer-to-consumer.

how startups are embedded in their value networks, a particularly decisive element for CBMs. This includes their patterns of value network integration, sales logic, and ownership structures, all of which shape their capacity to implement and scale circular strategies. Each startup can exhibit multiple characteristics within a dimension, as the taxonomy allows for non-exclusive, combinatory categorization.

Specific dimensions apply conditionally. For example, the dimension *product design* is relevant only if the startup provides a product, whereas service design applies only in service-based models. Nonetheless, the taxonomy is designed to capture circularity across the full spectrum of startup activities, extending beyond core offerings to include supporting operations and systemic contributions.

4.1 | Value Proposition

4.1.1 | Offering

The first dimension of the taxonomy, *offering*, captures the fundamental nature of what the startup provides to its customers, namely, whether the BM is centered around a physical product, a service, or a combination of both. This high-level differentiation serves as an essential analytical anchor for assessing a CBM, as it determines the structural pathway through which circular strategies may be implemented. A product-based offering may incorporate circular principles through material choices and design for disassembly, whereas service-based offerings often embed circularity through digital integration, platforms, or infrastructure. Based on expert feedback, this initial categorization proved crucial for interpreting downstream dimensions such as product and service design, which detail how circularity is embedded in the specific configuration of the offering.

4.1.2 | Product Design

For startups with a product-based BM, the *product design* dimension captures how circular principles are embedded in the

physical configuration of the offering. Circular product design can take several forms across different stages of the product lifecycle. Based on the data, we identified six recurring design logics. First, some startups pursue low resource input, aiming to minimize the quantity of virgin materials required in production. This is achieved either by using alternative raw materials, often sourced from waste or secondary streams, or by optimizing manufacturing processes to improve material efficiency (Bocken and Ritala 2021; Manninen et al. 2018).

Second, design for longevity involves increasing product durability and functional lifespan. These models contribute to slowing material loops by minimizing the need for replacement over time (Geissdoerfer et al. 2018; Manninen et al. 2018).

Third, we observed models characterized by modularity and adaptability, enabling easy repair, upgrade, or reconfiguration of components. Such design strategies allow users to extend a product's utility through interventions during use and are aligned with circular principles, slowing the material cycle (Pieroni et al. 2021).

A fourth strategy centers on material circulation, in which products are deliberately designed to be disassembled and re-integrated into future production cycles. This involves careful material selection, for example, monomaterial components, and design choices that support reuse or recycling at end of life (Bocken and Ritala 2021). The delineated design strategies for a product are systematically deliberated upon in a process-oriented fashion, commencing from production considerations and extending to postconsumer usage scenarios that contribute to the CE ethos. This characteristic is further specified in the *raw materials* dimension.

Startups that do not implement any of these strategies were classified under conventional product design, indicating an absence of deliberate circularity in the product configuration. In cases where the startup does not offer a physical product but is service-based, we coded this dimension as no product offering to preserve analytical clarity and avoid forced categorization.

4.1.3 | Service Design

In BMs centered around service provision, the *service design* dimension captures how circular principles are embedded in the delivery, coordination, and functionality of the service. Our taxonomy distinguishes five types of service logic based on empirical patterns and expert feedback. One prominent form involves algorithm-based services, where startups deploy digital technologies such as artificial intelligence (AI) or image recognition to optimize resource flows, for example, improving waste separation, material tracking, or logistics. These services may support different lifecycle stages, from beginning-of-life (extraction and manufacturing), middle-of-life (wholesale, retail, logistics, and customer usage), and end-of-life (repair, reuse, and remanufacturing) recovery (Yang et al. 2014).

A second model type is the collaborative consumption platform, where startups mediate access-based or second-life transactions between users (Lacy et al. 2020). These platforms extend the lifespan of under-utilized or defective goods by enabling reuse, remanufacturing, or component harvesting (Han et al. 2020). Sharing-based applications such as mobility or equipment rental fall into this category (Bocken et al. 2014).

Third, some startups provide supportive infrastructure for circular ecosystems, for instance, by offering take-back systems, refurbishment logistics, or data management services that facilitate traceability or loop closure for other actors (Antikainen and Valkokari 2016; Das et al. 2022; Mentink 2014).

Startups whose service design did not exhibit any of these characteristics were coded as conventional service design, and those without identifiable service components were categorized under no service offering. These characteristics distinguish service-based circularity from product-driven models and preserve conceptual clarity across the taxonomy.

4.2 | Value Creation

When looking into the processes and activities, resources, and capabilities within circular startups and how these elements are orchestrated to create value, their CBM can be categorized into four dimensions: *raw materials*, *CE operational logic*, *ecological contribution*, and *social contribution*.

4.2.1 | Raw Materials

We decided to specify the characteristic *material circulation* from the product design dimension in a separate dimension *raw materials* to illuminate the type and origin of materials used by circular startups in their production processes. This aspect of value creation is crucial for determining and assessing the startup's CE operational logic and its ecological contribution, as material selection directly affects biodegradability, recyclability, and the potential for closed-loop systems. Based on the data, we identified four distinct characteristics. The first characteristic is *upcycled waste streams* or *recycled materials*, often referenced in industrial symbiosis. These include preconsumer or

postconsumer waste streams, generated during production processes or disposed products, that are reintegrated into production (Blomsma et al. 2019; Potting et al. 2017).

Second, a CBM creates value by sourcing *recyclable materials*, which are easily recyclable under existing infrastructure, typically in the form of monomaterials. Experts emphasized this as a pragmatic yet impactful strategy.

Third, biodegradable materials present a sourcing option. These organic materials can be broken down by microorganisms, such as bacteria and fungi, into natural substances within a reasonable time frame (European Chemicals Agency 2023). This decomposition depends on environmental conditions such as temperature, moisture, and the presence of microorganisms (Zhao et al. 2023).

Lastly, sourcing renewable materials is a distinct characteristic of circular startup CBMs (Blomsma et al. 2019). Renewable materials are derived from resources replenished naturally over short periods, typically within a human lifespan (Guo 2024).

Startups that do not fall into any of these characteristics were classified as relying on conventional sourcing, typically oriented around cost-efficiency rather than circularity. In some cases, the absence of material sourcing altogether was due to the startup offering purely a service-based solution and was coded accordingly.

To capture the range of sustainability-related effects created by circular startups, we conceptually differentiate between three dimensions: *CE operational logic*, *ecological contribution*, and *social contribution*. These dimensions reflect different analytical levels. *CE operational logic* captures the strategic intent of the business model in pursuing circularity. *Ecological contribution* refers to the tangible environmental outcomes resulting from these strategies. *Social contribution*, in turn, addresses the third pillar of sustainability, capturing societal outcomes induced by the startup's social activities. This conceptual distinction between circular strategies and their realized effects in the environmental and social domain enhances the explanatory power and practical diagnostic value of the taxonomy.

4.2.2 | CE Operational Logic

We addressed the conceptual breadth of the *CE operational logic* dimension by drawing on the R-principles framework (Kirchherr et al. 2017; Morsetto 2020), where each R represents a different degree of circularity, ordered by its potential environmental impact (see Table 2). This framework is commonly used in practice, especially by experts working with startups to assess and support circularity efforts, allowing for consistent categorization while preserving domain relevance. We distinguish strategies according to the type of action applied to the product or material flow. Whereas strategies such as *reduce* and *recycle* primarily affect the material and resource flow during production or end-of-life processing, *reuse* and *repair* target the use phase of products by

TABLE 2 | CE Operational Logic of startups according to Morsetto (2020).

CE operational logic	Definition
Reduce	Increase efficiency in product manufacture or use by consuming fewer natural/limited resources and materials
Reuse	Reuse of discarded product by another consumer which is still in good condition
Repair	Repair and maintain defective products so it can be used with its original function
Recycle	Process materials to obtain the same (high grade) or lower (lower grade) quality
Enable others	Enable other actors to incorporate circular principles in their business model
No CE operational logic	The start-up does not contribute to a CE

extending functionality. The strategy *enable others* operates at the interorganizational level, supporting circularity through enabling circular practices in other actors or disseminating knowledge rather than implementing a circularity strategy themselves. This form of mediated or enabling impact can also apply across both the ecological and social dimensions and has therefore been treated as a valid but distinct mode of contribution within the taxonomy. This differentiation allows for consistent classification across startups with diverse circular operational models.

4.2.3 | Ecological Contribution

The *ecological contribution* dimension captures the actual or intended environmental effects of the BM CE-related operational activities. For this taxonomy, we have adopted the three broad ecological domains, *land*, *air*, and *water*, which align with established environmental frameworks, such as the planetary boundaries (Steffen et al. 2015). This abstraction emerged as a direct response to expert feedback, which emphasized the need to operationalize ecological contributions in a manner accessible to practitioners without requiring deep ecological expertise. Startups can generate a positive environmental impact on *land*, for instance, by promoting sustainable land use or enhancing biodiversity. Contributions related to *air* include mitigating climate change through greenhouse gas reduction or decreasing air pollution by minimizing atmospheric aerosol emissions. The *water* domain encompasses actions aimed at conserving freshwater resources or protecting marine ecosystems. Importantly, not all startups exhibit direct impact in each domain; in some cases, contributions may be indirect or absent, which is reflected in the coding structure of the taxonomy.

4.2.4 | Social Contribution

The *social contribution* dimension elucidates whether a startup integrates societal activities beyond economic and ecological impact into its CBM. Startups may contribute to community development through activities such as local job creation or support for regional education initiatives (Eckerle et al. 2024). Another frequently observed pattern involves community engagement, in which startups seek to influence regulatory frameworks in favor of CE principles by collaborating with local stakeholders or advocating for systemic change, a practice strongly emphasized by expert feedback. Additionally, some startups engage in other or indirect forms of social contribution, such as philanthropic donations or awareness-raising initiatives. However, not all startups exhibit observable activities in this domain; the taxonomy, therefore, also accounts for cases of absent social engagement.

4.3 | Value Network

Whereas internal capabilities and resources form the core of any BM, the CE paradigm places particular emphasis on external interactions. Circular startups often depend on networks of suppliers, recyclers, customers, and institutional actors to realize material loops, enable take-back mechanisms, or facilitate knowledge exchange. As such, the value network is not merely a supportive structure but a strategic enabler of circularity. The following dimensions assess how circular startups embed themselves in such networks through value network integration, sales models, and ownership configurations.

4.3.1 | Value Network Integration

The CE inherently depends on the integration of diverse actors across organizational and sectoral boundaries, an aspect captured in the dimension *value network integration*. This dimension reflects the extent to which startups establish strategic partnerships that support circular value creation and delivery. A common form includes cross-industry collaborations, particularly when startups partner with manufacturing firms to repurpose industrial by-products, such as textile offcuts, agricultural, or food waste, into new circular offerings (Henry et al. 2020). Beyond cross-industry collaborations, we also observed operational collaborations along the supply chain, such as partnerships with logistics or waste management providers to organize reverse logistics and enable take-back systems (Lacy et al. 2020). These systems allow for the structured return of used products or materials from end-users back into the production cycle, often relying on third-party actors for collection, sorting, and reintegration. Expert interviews also revealed occasional instances of knowledge-based collaborations, such as with academic institutions or circularity consultants. Legitimacy-oriented alliances with NGOs or public sector actors, as a form of engagement, were observed infrequently and lacked consistent documentation across the dataset. As such, they were categorized under a general *other* characteristic to acknowledge their presence without overstating their prevalence. Notably, some circular startups operated with no observable integration into external value networks.

4.3.2 | Sales Model

To further unpack the dynamics of the value network within CBMs, we include the dimension *sales model*, which specifies the primary customer interface through which the startup delivers its offering. This dimension reflects the nature of the transactional relationship and the intended target group. Most startups in the sample followed a business-to-business (B2B) model, engaging with corporate clients across industries. Others operated under a business-to-consumer (B2C) logic, offering products or services directly to end-users. A smaller subset enabled consumer-to-consumer (C2C) transactions, often through digital platforms that facilitate the reuse of products by sharing or reselling. Notably, several startups pursued public-sector-oriented models, providing circular solutions directly to municipalities, schools, or government agencies, an arrangement we refer to as government-to-business (G2B) to capture its distinct logic. Finally, some circular startups adopted alternative models, such as B2B2C, wherein products are sold to businesses that then distribute them to end consumers.

4.3.3 | Ownership

The *ownership* dimension captures the degree to which circular startups retain control over their products or services throughout the lifecycle. We distinguish between two main configurations. First, producer ownership is given when the startup maintains ownership of the product or service throughout its use. This includes leasing, pay-per-use arrangements, product-as-a-service models, and platform-mediated exchanges in which the producer retains legal ownership, whereas users gain temporary access. In CBMs, these alternative ownership structures are often associated with improved resource efficiency, extended product lifespans, and more effective reverse logistics (Bressanelli et al. 2022). These models align with CE principles by enabling the provider to maintain responsibility for the product and ensure its reintroduction into the loop. Although leasing and rental arrangements were often explicitly mentioned, it was frequently unclear from publicly available sources whether access was granted through usage-based billing or other pay-per-use mechanisms. To maintain consistency and avoid over-interpretation, we therefore aggregated these models under the broader category of producer ownership.

However, our data indicate that such ownership-retention models remain relatively rare among circular startups. Thus, the second distinction in this dimension is consumer ownership. In most cases, ownership is transferred to the customer upon purchase, reflecting either market constraints or the perceived complexity of service-based revenue models. This binary classification emerged from the data and proved analytically robust across cases.

Although more complex hybrid forms exist, especially in platform-based contexts, we found that they align more closely with the producer ownership logic, given the provider's continued control over pricing, conditions of use, and reverse logistics. Nonetheless, the presence or absence of ownership retention plays a significant role in shaping the circular potential of a given BM and is therefore included as a distinct dimension in the taxonomy.

5 | Applying the Taxonomy to Inform Ecosystem Support Design: A Startup Case

To demonstrate the practical utility of the developed taxonomy, this section presents a real-world application that illustrates how it can inform EE actors, particularly policymakers, in two key areas: (1) identifying need-based support mechanisms for circular startups and (2) enhancing the circularity embedded in their BMs. The case example was selected from the same dataset of 125 startups used in the taxonomy development and is based exclusively on publicly available information. This ensures consistency in the data basis and reinforces the taxonomy's applicability to early-stage assessment scenarios.

5.1 | Case Description

The selected case features Traceless Materials GmbH, a material innovation startup that develops a novel biomaterial derived from industrial by-products, which can serve as a sustainable alternative to conventional plastics. The material is fully biodegradable, nontoxic, and designed for a wide range of applications, including packaging and single-use product replacement. The CBM follows a B2B logic, targeting manufacturers seeking to replace fossil-based plastics with environmentally benign alternatives. The structural configuration of the BM according to the taxonomy is depicted in Figure 5.

In taxonomic terms, the startup exhibits a product-centric BM with no discernible service component. Its product design is characterized by low resource input and material circularity: The biomaterial is derived from repurposed agricultural residues and compostable under natural conditions. The startup sources recycled and biodegradable raw materials, aligning with CE principles from the outset of the production cycle.

The circular strategy follows a *reduce* logic by substituting conventional plastic with low-impact alternatives and *recycling* by valorizing industrial by-products from other sectors.

Although no direct ecological effects, such as biodiversity enhancement, CO₂ mitigation, or water conservation, could be verified in public data, the startup likely contributes indirectly by reducing plastic pollution and dependence on non-renewable resources. No social contributions were identified.

The value network is characterized by cross-industry collaborations with upstream agricultural partners, who provide input materials, as well as with processing industries along their supply chain to codevelop suitable applications of the new material for them. The startup pursues a B2B sales model, transferring ownership of the product to purchasing firms.

5.2 | Analysis

5.2.1 | Needs

Based on this structural configuration of the startup's CBM, which enables the scaling of such innovations, specific needs relevant to policymakers can be identified. First, the lack of

	Dimension	Characteristics									
Value Proposition	Offering	Product					Service				
	Product Design	Low Resource Input	Longevity	Modularity and Adaptability	Material Circulation	Conventional Product Design	No Product Offering				
	Service Design							Algorithm-based (incl. AI)	Collaborative Consumption Platform	Supportive Infrastructure	Conventional Service Design
Value Creation	Raw Materials	Recycled Materials	Recyclable Materials	Biodegradable Materials	Renewable Materials	Traditional Sourcing	No Product Offering				
	CE Operational Logic	Reduce	Reuse		Repair		Recycle	Enable Others		No Contribution to CE	
	Ecological Contribution	Land		Air		Water		Indirect Ecological Contribution	No Ecological Contribution		
	Social Contribution	Employment	Education		Community Engagement		Other	Indirect Social Contribution	No Social Contribution		
Value Network	Value Network Integration	Cross Industry Collaboration		Value Chain Collaboration		Knowledge-Based Collaborations		Other	No Integration		
	Sales Model	B2B		B2C		C2C		B2G	Alternative Models		
	Ownership	Producer						Consumer			

FIGURE 5 | Case illustration: mapping a circular startup's business model using the taxonomy (own illustration).

established certification schemes for novel biomaterials can hinder market acceptance. Second, access to particular waste streams as input materials is often fragmented or subject to restrictive regulation. Third, startups that target B2B customers with material innovations often struggle to access industrial buyers due to limited credibility, small scale, and weak bargaining power. Fourth, the capital intensity of building proprietary production infrastructure creates financing hurdles, particularly at early stages.

5.2.2 | Design of Support

Against this backdrop, the taxonomy helps identify corresponding support levers for EE actors. First, from a regulatory perspective, policymakers possess powerful steering instruments to foster the diffusion of circular innovations. Startups introducing novel biomaterials often face the dual challenge of market uncertainty and regulatory ambiguity. Codeveloping certification standards or integrating such materials into public procurement guidelines not only legitimizes the innovation but can also create a guaranteed market pull (Droege et al. 2023; Rao et al. 2024).

Second, startups working with residual resources depend on building complex partnerships across sectors to secure consistent material streams. However, their early-stage nature often limits access due to a lack of credibility, scale, or contractual leverage. Policymakers can act as intermediaries by facilitating access to residual waste through municipal waste management systems or embedding startups in industrial symbiosis programs (Moss et al. 2022; Rocha et al. 2023).

Third, policymakers should create targeted B2B matchmaking formats that connect material-innovating startups with potential industrial buyers. These platforms can help overcome credibility gaps and reduce entry barriers by offering curated access, third-party validation, and moderated negotiation spaces that balance power asymmetries between startups and incumbents (Bauwens et al. 2024).

Fourth, the development of hardware-intensive solutions, such as large-scale production facilities, represents a high-risk,

capital-intensive endeavor. Given the typical risk-aversion of private investors in early stages, startups often face a financing gap (Fang and Parida 2024). Public actors can play a catalytic role by providing de-risking instruments, innovation grants, or blended finance schemes tailored to the specific needs of circular production technologies.

5.2.3 | Enhancing Circularity

In addition, the taxonomy highlights the potential to improve the startup's circularity further, for instance, by supporting end-of-life processes such as compostability integration into public waste systems or improving recyclability tracking.

This application example illustrates how the taxonomy can serve not only to classify CBMs but also to inform EE actors in designing tailored interventions that address startups' structural needs while unlocking greater circular impact. Figure 6 visualizes the final taxonomy as a structured, yet dynamic, analytical framework that can also serve as a high-level decision aid for ecosystem actors. The straight arrows denote the sequential taxonomy flow, guiding users through a typical classification process. Ecosystem actors can use the taxonomy as a stepwise diagnostic tool: first, by characterizing the startup's CBM along the offering-related dimensions (offering, product and/or service design, and raw materials) and the CE operational logic; second, by assessing how this configuration currently translates into ecological and social contributions, including where such contributions are weak or absent; and third, by identifying which parts of the business model are most dependent on external enablers, typically in the value network, and aligning support instruments accordingly. The curved arrows indicate interdimensional interrelations, that is, conceptual or operational linkages between taxonomy dimensions that frequently co-occur or mutually influence one another. By integrating both directional and relational logic, the visual framework supports ecosystem actors in identifying not only what a startup does but also how different elements of its BM interact. This enables the derivation of more targeted support interventions, the anticipation of systemic bottlenecks, and more strategic alignment within the ecosystem.

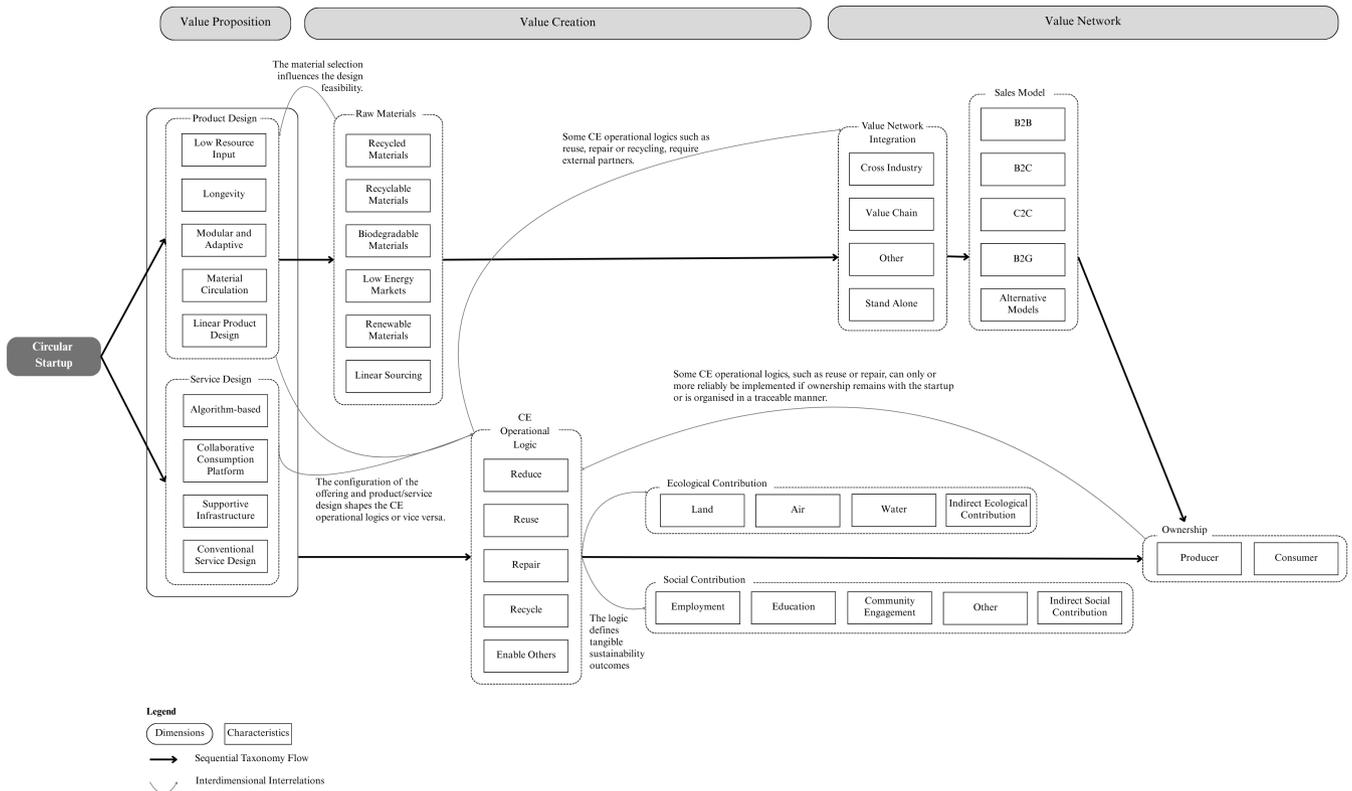
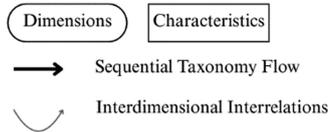


FIGURE 6 | Taxonomy of circular startups: sequential flow and dimensional interrelation (own illustration). Legend:



6 | Discussion

Circular startups are instrumental in driving the shift toward a CE. However, their ability to overcome structural barriers and scale their impact often depends on targeted support from EEs. Despite this strategic importance, research to date lacks a structured understanding of the BMs employed by these startups, a gap that limits the ability of EE actors to design effective support mechanisms.

This study set out to address this gap by identifying the key dimensions and characteristics of CBMs in startups. Drawing on core constructs from BM theory, namely, value proposition, value creation, and value network, we developed a taxonomy grounded in empirical data. Following the methodological framework by Kundisch et al. (2022), the taxonomy was informed by an SLR and an empirical-to-conceptual analysis of 125 real-world CBM cases. Two evaluation cycles were integrated into the process to assess practical relevance and ensure applicability for EE actors.

The resulting taxonomy comprises 10 dimensions and 48 distinct characteristics. Rather than functioning in isolation, these dimensions interact in meaningful ways. Accordingly, the taxonomy does not merely offer a descriptive classification but serves as a relational, analytical tool for understanding and comparing CBM of startups.

6.1 | Comparison to Prior Work

Although research on CBMs has expanded in recent years, dedicated attention to the BMs of circular startups remains limited. To date, the most prominent effort in this space is the typology developed by Henry et al. (2020), which categorizes circular startups based on patterns of circular innovation. Their study aimed to create a conceptual understanding of startup CBMs by synthesizing two established frameworks in the CE literature. In contrast, the present study follows a taxonomic logic, focusing on the structural dimensions and operational characteristics of startup CBMs. Rather than identifying types, we systematically map the heterogeneity and configurational complexity of circular startups, grounded in BM theory and oriented toward practical application. This shift in perspective enables a more nuanced understanding of BM variation and provides a foundation for both empirical comparison and targeted EE support.

Several of the dimensions identified in this study align with prior conceptualizations of CBMs yet offer new levels of granularity and empirical grounding. Table 3 summarizes the alignment and divergence between our taxonomy and prior CBM research across all 10 dimensions. One foundational distinction between product and service offerings resonates with earlier work by Lüdeke-Freund et al. (2019), who emphasize the structural importance of differentiating types of value proposition in circular models. This differentiation is not merely descriptive,

TABLE 3 | Novel and extended dimensions of circular startup CBMs compared to prior work.

Dimension	Prior work	Our taxonomy	Novelty
Offering	Differentiation product/service (Lüdeke-Freund et al. 2019)	Retained, used to anchor downstream dimensions	Confirmation; foundational entry point
Product design	General design-for-circularity (Urbinati et al. 2017)	Distinct strategies: low resource input, longevity, modularity, etc.	Structured across lifecycle; startup focus
Service design		Includes algorithm-based designs, collaborative consumption platforms, and supportive infrastructure services	Original classification of circular services
Raw materials	Recycled/renewable inputs (Blomsma et al. 2019)	Adds recyclable, biodegradable; distinguishes sourcing from absence	More granular; startup-specific constraints
CE operational logic	Broad strategy sets (Bocken et al. 2016; Henry et al. 2020)	Focus on reduce, reuse, repair, recycle, and enable others	Empirical prioritization and separation from outcome dimensions
Ecological contribution	Sustainability as external outcome (De Keyser and Mathijs 2023)	Distinct dimension capturing direct/indirect environmental outcomes	Conceptual innovation
Social contribution	Sustainability as external outcome (De Keyser and Mathijs 2023)	Includes employment, education, community, and other	Adds socio-institutional embeddedness to CBM analysis
Value network integration	General call for collaboration (Lacy et al. 2020; Lüdeke-Freund et al. 2019)	Differentiates cross-industry vs. value chain vs. knowledge-based vs. other collaboration	More specific
Sales model	B2B/B2C (Piispanen et al. 2020)	Adds C2C, B2G, and alternative forms	First taxonomy to capture B2G logic in circular CBMs
Ownership	Retained/shared ownership referenced (Lewandowski 2016)	Binary coding: producer vs. consumer ownership	Clarifies lifecycle control structure

but analytically consequential, as it determines the pathways through which circular value can be generated and maintained. Building on this foundation, the present taxonomy further specifies how circular strategies are embedded operationally, an area where notable overlaps and refinements emerge in comparison to previous studies.

In particular, the dimension *CE operational logic* confirms earlier findings that emphasize circular strategies as a key differentiator in BM design (Bocken et al. 2016; Lüdeke-Freund et al. 2019; Moreno et al. 2016). Similar to these studies, and in line with Henry et al.'s (2020) typology, our findings confirm that CE strategies constitute a foundational element in characterizing startup CBMs. However, whereas earlier frameworks have identified a broad spectrum of circular strategies, ranging from regeneration and remanufacturing to recovery (Blomsma et al. 2019; Lüdeke-Freund et al. 2019; Uvarova et al. 2023), our analysis reveals a more focused set of operational logics adopted by startups.

Specifically, the strategies of reduce, reuse, repair, and recycle, along with enabling others, emerged as the most prevalent and operationally embedded approaches in our sample. These strategies directly inform how startups create circular value and thus form the core of the *CE operational logic* dimension. In contrast,

strategies such as regeneration, remanufacturing, and recovery were rarely observed and did not align with the dominant logic of circular startups. To reflect this distinction, we treated regenerative effects not as a direct operational strategy but as part of the separate dimension of *ecological contribution*, which captures the environmental outcomes resulting from a startup's BM operational activities. This conceptual boundary ensures analytical clarity while acknowledging the broader sustainability impact of CE practices.

The inclusion of a *raw materials* dimension further confirms prior research emphasizing sustainable sourcing as a core element of CBMs. Studies on incumbent firms have identified the use of recycled or renewable materials as a key strategic lever (Blomsma et al. 2019), reflecting growing awareness of procurement as a part of circular innovation. Our findings support this view but also reveal a more differentiated picture in the context of startups.

Specifically, the taxonomy distinguishes between recycled, recyclable, biodegradable, and renewable inputs, while also accounting for startups that rely on conventional sourcing practices or do not engage in material flows at all. This expanded classification reflects both the diversity of sourcing strategies of startups and the challenges they face in accessing circular inputs.

Although some overlaps with incumbent strategies are evident, the nuanced treatment of raw materials in our taxonomy allows for a more precise assessment of how circularity is operationalized at the input level of startups.

Building on the upstream perspective captured in the *raw materials* dimension, our taxonomy also offers a more granular view of the startup's external configuration through the dimensions *value network integration* and *sales model*. Although earlier studies have acknowledged the role of partnerships and customer segments in CBMs (Lacy et al. 2020; Lüdeke-Freund et al. 2019; Piispanen et al. 2020), these aspects were often treated at a general level, particularly in the context of incumbent firms. Our taxonomy advances this understanding by distinguishing between cross-industry collaborations, value chain collaborations, knowledge-based collaborations, and other network configurations on the one hand, and between B2B, B2C, C2C, B2G, and alternative sales logics on the other. Especially, the presence of a (B2G) sales logic, absent from prior CBM classifications, underscores the political and institutional interface in which circular startups increasingly operate (Van Opstal and Borms 2023).

In addition to these dimensions, prior studies have also surfaced individual characteristics that resonate with our findings. For example, *collaborative consumption platforms* have been discussed as enablers of indirect reuse, functioning as intermediaries that extend product lifecycles by facilitating second-hand transactions or shared use (Moreno et al. 2016). Similarly, the characteristic of *low resource input*, highlighted in earlier work on eco-efficient manufacturing, aligns with one of the product design strategies captured in our taxonomy, emphasizing material minimization and process optimization (Bressanelli et al. 2018).

The *ownership* logic embedded in different BMs has likewise been noted in previous research, distinguishing between models in which firms retain product ownership and those that rely on full transfer to consumers (Lewandowski 2016). Although such distinctions have often been mentioned in passing, their systematic integration into a taxonomy of startup CBMs offers new clarity and facilitates empirical comparability.

In contrast to existing work, which often treats “ecological and social contributions” as external outcomes or side effects of CBMs (De Keyser and Mathijs 2023), our taxonomy integrates these dimensions as intrinsic components of BM design. Rather than analyzing sustainability contributions in isolation, we conceptualize them as outcomes that are systematically linked to the circular strategies captured in the “CE operational logic” dimension.

The *ecological contribution* dimension captures both direct and indirect environmental impacts on land, air, or water. Importantly, these contributions are not ancillary but often constitute a core part of the startup's value creation logic. Similarly, the *social contribution* dimension extends beyond internal employment effects to encompass broader societal engagement, such as education involvement, support for regulatory transformation, or investment in support initiatives. These aspects are rarely systematized in existing taxonomies but emerged as consistent patterns in our sample.

6.2 | Theoretical Contribution and Practical Implications

Reflecting on the objectives of this study, we now turn to the broader contributions of our findings. The development of the taxonomy was motivated by two complementary aims: primarily, to advance the theoretical understanding of how circular startups configure their BMs and, additionally, to offer a practical tool that enables ecosystem actors to more effectively support these startups.

6.2.1 | Theoretical Contribution

With respect to the theoretical development of CBM literature, our study clarifies how startups operationalize circularity through distinct and empirically grounded configurations. We advance CBM theory in several ways: We delineate the building blocks through which circularity is embedded in the business logic of startups; we specify the operational and systemic mechanisms by which environmental and social value is created; and we differentiate startup CBMs from both conventional and incumbent models in terms of structure, logic, and ecosystem interaction. From these advancements, we contribute to the definition of a startup's CBM.

To begin, we delineate the core components through which circularity is embedded in the business logic of startups. Building on the BM lens, the taxonomy structures startup CBMs along the dimensions of value proposition, value creation, and value network. At the value proposition level, it distinguishes whether a startup offers a product or a service. Product-focused models often integrate circularity through low resource input, longevity, modularity, and material choice. In contrast, service-based CBMs draw on algorithm-based solutions, collaborative consumption platforms, or supportive infrastructures that facilitate circular processes, such as return systems or loop-enabling data services. In terms of value creation, circular startups differentiate themselves through the sourcing of materials, opting for recycled, recyclable, biodegradable, or renewable resources. These material choices are closely intertwined with the CE operational logic embedded in their operations, such as reducing resource use, reusing or repairing products, recycling materials, or enabling circularity in others. This structural framing enables a nuanced understanding of how circularity is not simply added onto existing models but embedded in their foundational architecture.

A second contribution concerns the integration of environmental and social value creation into the BM architecture itself, as outlined beforehand, positioning environmental and social contributions not as a byproduct but as a central dimension of CBMs. In doing so, this study responds to recent calls for research that foregrounds the social objectives of circular entrepreneurship, an area that remains underexplored, particularly in quantitative and structural analyses of CBMs (Alam et al. 2019; Borrero and Yousafzai 2025; de Angelis and Vesci 2025; Ghisellini et al. 2016).

Finally, this study differentiates circular startup CBMs from both conventional startups and incumbent firms by highlighting distinctive structural, strategic, and relational

configurations. In contrast to conventional startups, circular startups adopt a broader value logic that extends beyond economic viability to include ecological and social considerations. Their BMs are designed not only to generate revenue but also to consider environmental harm, foster social activities and ensure responsible stewardship of resources. This commitment is reflected in design decisions, operational logics, and particularly in ownership logics: Rather than transferring responsibility at the point of sale, circular startups retain ownership to maintain control over product lifecycles and enable closed-loop processes.

Compared to incumbent firms, circular startups operate under fundamentally different conditions. Lacking established infrastructures, they rely more intensively on external collaborations to realize circular value (Kanda et al. 2025). Accordingly, their CBMs place greater emphasis on value network integration, unconventional sales logics (including B2G), and, in a few cases, ownership retention to maintain control over product lifecycles. As discussed above, our taxonomy makes these differences visible by systematically capturing network integrations, sales, and ownership models. Together, these features highlight the need for a distinct conceptual category within CBM research that captures the specific configuration logic of startups and reflects their role as experimental drivers of the CE.

6.2.2 | Practical Implications

Beyond its theoretical contribution, the taxonomy also provides an analytical framework that supports the practical analysis and comparison of CBMs in entrepreneurial contexts. These practical implications extend well beyond the classification of startups: The taxonomy reveals how different elements of a BM are configured and interrelated, offering a systemic view of circularity in practice. This structured understanding supports four key objectives for ecosystem development: (1) the design of need-based support systems tailored to specific startup configurations, (2) the enhancement of circularity of startups by identifying strategic and operational gaps, (3) the strategic steering of EE portfolios to foster diversity and complementarity, and (4) the establishment of a shared language that improves communication and coordination among EE actors.

To demonstrate how these implications can be operationalized, Section 5 presents a real-world application of the taxonomy based on a representative material innovation startup. The case illustrates how policymakers can use the taxonomy to identify targeted support needs, such as access to residual waste, certification of novel materials, or infrastructure for recovery systems, and how such support can enhance the circularity logic of a given CBM. The mapping of BM interdependencies further supports this process by offering a diagnostic tool to uncover leverage points across the value proposition, value creation, and network configuration. These interdependencies underscore the systemic nature of circular innovation. As recent studies show, enabling conditions, such as knowledge infrastructures, mentoring networks, and collaborative policy environments, are essential for circular startups to

thrive (see e.g., Kanda et al. 2025; Kumari et al. 2025; Manu et al. 2025). In this light, our taxonomy and its visual representation (Figure 6) function as a stepwise diagnostic tool that helps ecosystem actors classify startup CBMs, identify structural gaps, and derive targeted support interventions in practice.

6.3 | Limitations and Future Outlook

Although this study provides a robust and empirically grounded taxonomy of circular startup CBMs, its findings should be understood as a foundation for further conceptual refinement. As Nickerson et al. (2013) note, taxonomies are inherently imperfect and evolve as new phenomena emerge. Future research should revisit and iteratively adapt the taxonomy as the landscape of circular startups expands and diversifies. This is particularly relevant in light of increasing experimentation with hybrid models, new material innovations, or evolving digital infrastructures that may give rise to previously unobserved dimensions or configurations.

Moreover, as the taxonomy is intended not only as a classification scheme but also as an analytical tool for EE actors, future work should explore how its categories resonate with diverse actors. Longitudinal studies could investigate how the taxonomy is adopted, challenged, or modified in practice and how it contributes to shared sense-making and alignment within EEs. This would ensure that the taxonomy remains both analytically relevant and practically actionable over time.

A second avenue for future research concerns the dimension of value capture, which was deliberately excluded from the final taxonomy. Although value capture is widely regarded as a core component of BM frameworks (see e.g. Lüdeke-Freund et al. 2019; Paukstadt et al. 2019; Sterk et al. 2024), our empirical data lacked sufficient consistency and granularity to support its meaningful inclusion. In particular, reliable insights into pricing mechanisms, cost structures, and monetization logic were often absent or not transparently communicated by early-stage startups. To integrate value capture into future taxonomy iterations, alternative data collection approaches may be necessary. Qualitative methods such as in-depth interviews could offer richer insights into how startups conceptualize and experiment with revenue models. A dedicated focus on this dimension would further strengthen the taxonomy's explanatory power and bring it in line with established theoretical frameworks in BM research.

Finally, the contextual boundaries of the study suggest further opportunities for comparative research. Although the sample of 125 startups aligns with the scope of similar taxonomy studies, it may not fully capture the diversity of CBM configurations across geographies, sectors, or firm maturity levels. Notably, all circular startups in our dataset were founded in or after 2018, primarily in Europe, reflecting early-stage dynamics. Investigating more established startups could reveal how CBMs evolve over time and how certain configurations stabilize, adapt, or dissolve in later growth phases. Additionally, analysis of non-European startups could yield insights into how CBMs adapt in less policy-driven or resource-constrained contexts.

In addition, the dataset shows a geographic bias toward European contexts where CE principles have been actively promoted through policy and institutional initiatives (e.g., the Netherlands since 2016, Sweden since 2020, and Germany since 2020). As regulatory frameworks, infrastructure maturity, and cultural norms vary across regions, future research should explore how CBMs are shaped under different institutional and socioeconomic conditions. Comparative studies across Global North and South, or between policy-intensive and market-driven CE environments, could offer valuable insights into context-contingent pathways toward circular entrepreneurship.

7 | Conclusion

This study develops and evaluates a taxonomy that systematically captures how circular startups embed CE principles into their BMs. By integrating insights from literature and empirical analysis of 125 startups, the taxonomy identifies 10 key dimensions and their interrelations, offering a structured lens to analyze and compare CBMs in entrepreneurial contexts. Beyond its theoretical contribution, the taxonomy provides a practical analytical framework for EE actors to design tailored support mechanisms and identify leverage points for enhancing circularity. As the CE evolves, the taxonomy can serve as a foundation for further empirical mapping, comparative analysis, and strategic ecosystem coordination.

Acknowledgements

Open Access funding enabled and organized by Projekt DEAL.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** List of analyzed start-ups.

Appendix A

- All objects or a representative sample of objects have been examined.
- No object was merged with a similar object or split into multiple objects in the last iteration
- At least one object is classified under every characteristic of every dimension.
- No new dimensions or characteristics were added in the last iteration.
- No dimensions or characteristics were merged or split in the last iteration.
- Every dimension is unique and not repeated.
- Every characteristic is unique within its dimension.
- Each cell (combination of characteristics) is unique and is not repeated.

